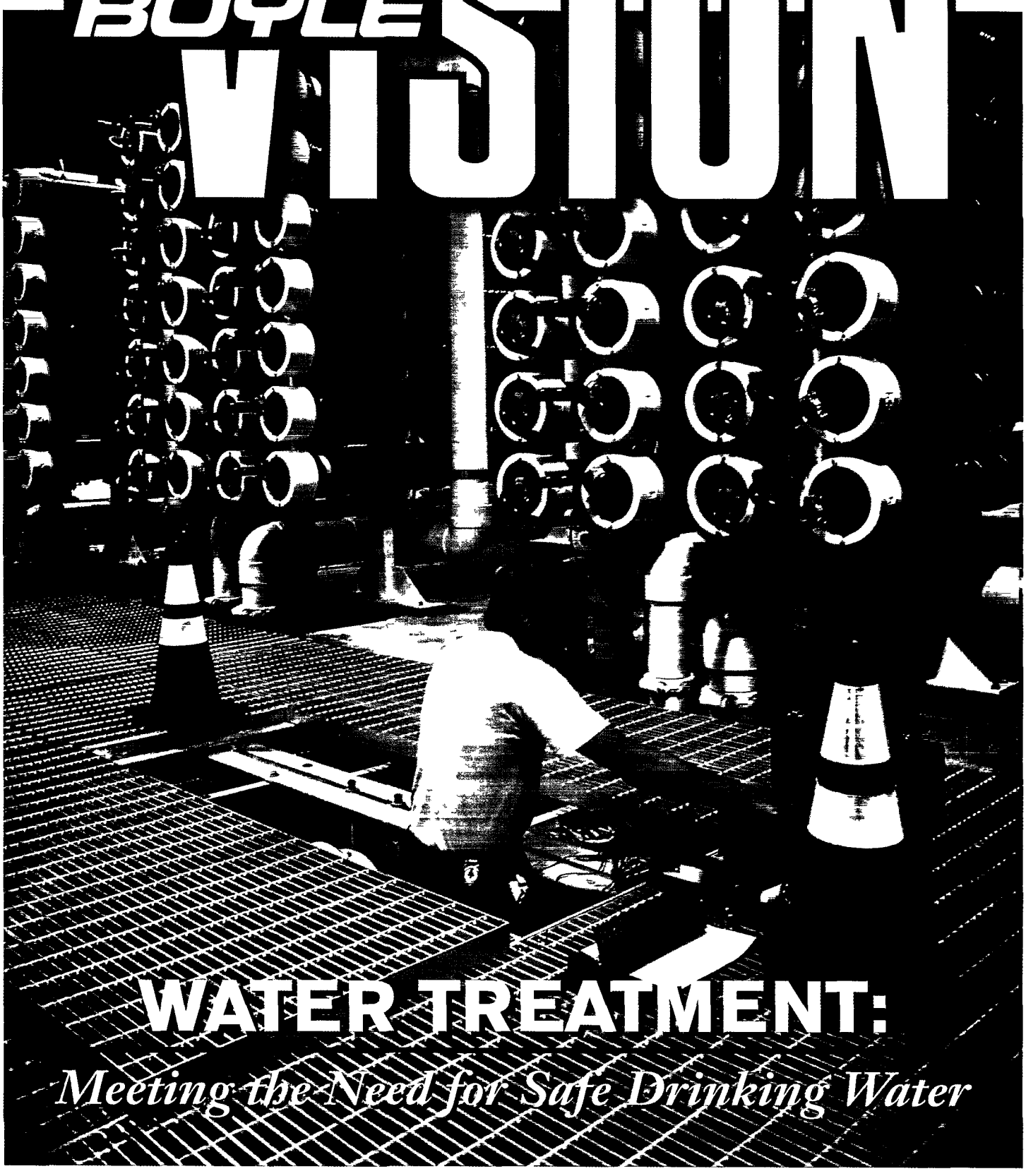
BOYLE VISION

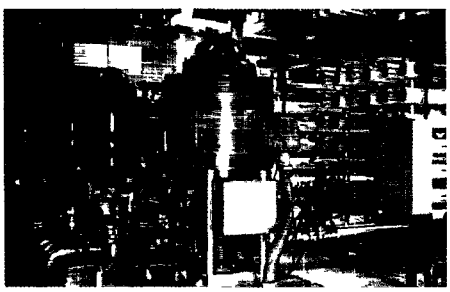


WATER TREATMENT:

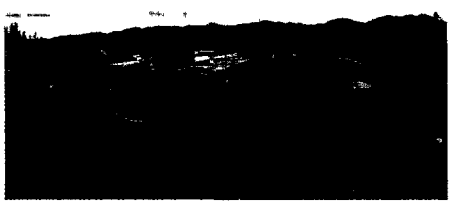
Meeting the Need for Safe Drinking Water

BOYLE VISION™

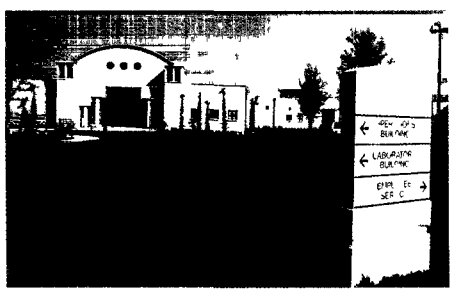
Vol. 9 No. 1 Issue I, 1998



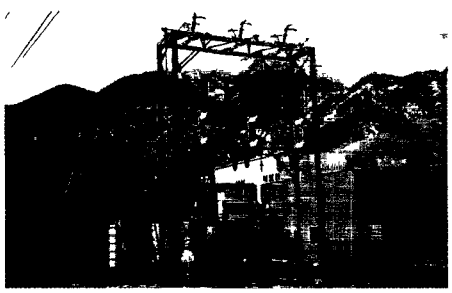
Reverse osmosis is important for Florida island



Conventional water treatment in northern Calif



New treatment plant doubles as operations center



Electrical upgrades at 113-MGD plant

Making Great Strides in Water Treatment

Not too long ago, few municipalities and utilities considered the use of advanced water treatment methods such as reverse osmosis and nanofiltration, primarily because the techniques were too expensive for more general applications. How things have changed. In many cases where the costs of advanced treatment once far outweighed the benefits, the scale has tipped the other way, and cities and water agencies throughout the country are now relying on membrane technology. Watching advanced treatment come of age is very rewarding for us here at Boyle.

Through our experts, we have remained a pioneer in advanced treatment for more than 10 years. During that time, we've designed the world's largest electrodialysis reversal water treatment plant and some of the world's largest membrane softening facilities, and also produced retrofit designs for large-scale reverse osmosis systems. Now, with advanced treatment becoming more pervasive, we're just as likely, and as happy, to do work for smaller cities like Las Animas, Colorado; Seymour, Texas; and Beverly Hills, California. This issue of Boyle VISION highlights some of our recent advanced treatment projects, including the Las Animas, Seymour, and Beverly Hills facilities.

Lest you think this issue is exclusively about advanced treatment, however, there are articles about conventional water treatment plants, wellhead treatment facilities, and other applicable technologies. The point is, we realize that every water system is unique and that the best water treatment application for a given situation depends on a number of technical and non-technical issues. It is for those reasons that this issue of Boyle VISION showcases a broad spectrum of water treatment methodologies.

We invite you to grab a cold glass of water, sit back in your favorite chair, and enjoy our insightful writeups. If you have any questions, call our office located nearest to you (the offices are listed on the back cover).

Tom Maddock, PE
Chairman of the Board

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With a new demineralization facility designed by Boyle, the Sweetwater Authority will have the capability to provide a minimum of 6 MGD of local water and up to 36 MGD in times of plenty.

Reverse Osmosis Plant Will Allow Utility to Use More Local Water

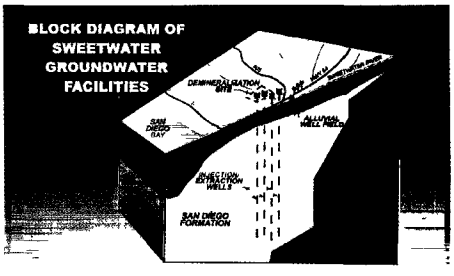
Integrated Water Resources Management (IWRM) and Aquifer Storage and Recovery (ASR) are two concepts that broadly encompass many different methods to maximize water resources. On a multifaceted project by the Sweetwater Authority, those methods include capturing stormwater runoff for potable use, combining the use of surface water and groundwater supplies, relying on both local and imported water sources, injecting treated water into a subsurface stratum that will act as a storage reservoir, and employing advanced treatment via a new reverse osmosis (RO) plant.

Al Shoyeb

◀ *At the recent groundbreaking for the Sweetwater Demineralization Facility, Boyle brought its pilot plant to show onlookers how the reverse osmosis process works.*

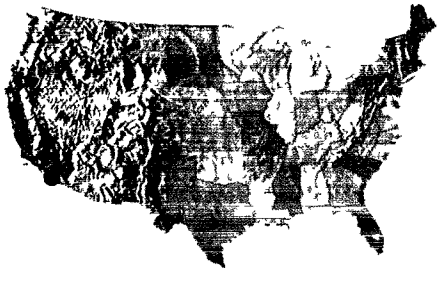
The Sweetwater Authority is a public water utility with 165,000 customers in southern San Diego County. Its main facilities include a 30-MGD conventional water treatment plant and the Sweetwater and Loveland reservoirs. In wet years, the authority's local water supplies are sufficient to meet demand, but when there is a water deficit, the utility relies heavily on imported water from the Metropolitan Water District of Southern California (MWDSC). A new 4-MGD (expandable to 8-MGD) RO plant designed by Boyle Engineering Corporation will eventually help make more local water available for use by Sweetwater Authority customers, even when rainfall is light. That's because the RO plant will treat previously unusable, poor-quality groundwater from the high-yielding San Diego formation. In addition, the new plant will allow the authority to make use of a shallow alluvial groundwater basin consisting partially of runoff from an innovative stormwater diversion system Boyle designed as a separate, but related, project.

Prior to designing the plant, Boyle engineers conducted a study to determine the feasibility of developing groundwater sources as an option to purchasing water from MWDSC. Study results indicated that, if the authority used both the alluvial basin and the San Diego formation, groundwater treated by RO was a cost-efficient alternative to importing water. Boyle subsequently designed four alluvial wells and five San Diego formation wells that will supply water to the plant. The San Diego formation wells can also serve as injection wells for ASR. Most likely, the authority will inject and, later, withdraw conventionally treated water that would otherwise spill over a dam at Sweetwater Reservoir during wet periods and flow into the ocean.



▲ *A block diagram depicts key components of the Sweetwater Demineralization Facility project.*

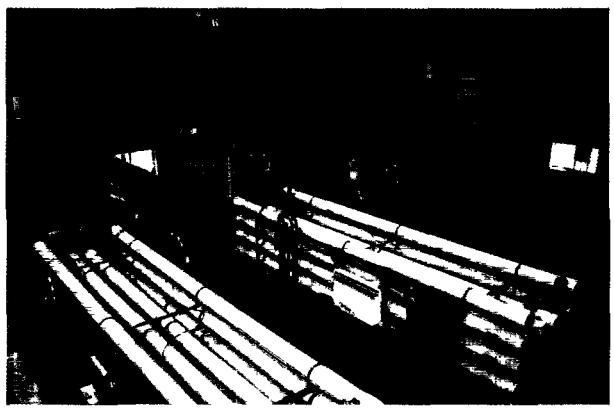
The plant site and the San Diego formation wells are near the coast, while the alluvial basin wells lie further inland to prevent saltwater intrusion during drawdown of the water table. A Boyle-designed pipeline will deliver the alluvial basin water to the plant. Construction of the plant is in progress, and when it begins operation shortly after the beginning of the year, the Sweetwater Authority will have a highly valued commodity in Southern California: a local water supply that will remain viable in the face of changing regulations, a growing customer base, and mounting uncertainties about the reliability of imported water.



San Diego County, California

Implementing a Membrane Treatment Solution in Colorado

Boyle Engineering conducted a pilot study and designed a reverse osmosis treatment plant to help the city of Las Animas improve its water quality.



▶ *The city of Las Animas is among a growing number of smaller cities that have turned to advanced water treatment methods.*

The city of Las Animas, Colorado, lies in the southeastern corner of the state. Potable water for the residents of Las Animas comes from groundwater from the lower Arkansas River alluvium. The water has a history of total hardness as high as 2,500 mg/L, total dissolved solids (TDS) from 3,500 to 4,500 mg/L, and sulfate in the range of 2,500 mg/L, all of which are unenviable numbers in terms of water quality. Previously, no formal means of water treatment existed in Las Animas, so residents relied heavily on bottled water and costly water-softening systems. Added to these expenses were the relatively frequent outlays for replacing water heaters and plumbing fixtures. What's more, residents needed to use excessive amounts of detergent to generate lather from the well water.

Looking for a long-term solution to its water-quality problems, the city turned to the team of Gilbert Morrill/Boyle Engineering Corporation. The first assignment for Boyle was to conduct a comprehensive pilot study. During a six-week period, project team members ran the pilot system and generated crucial data on how to reduce TDS, hardness, and sulfate. Pilot equipment consisted of a 1-gpm-permeate-capacity reverse osmosis (RO) unit, a 5-gpm-capacity manganese greensand filter, and a 2-gpm iron and manganese filter. The iron and manganese units operated in parallel, while the RO unit took its supply from the combined effluent of the iron and manganese filters. The RO unit functioned with brackish water membranes for four weeks and with nanofiltration membranes for two weeks. Study results indicated that a brackish water RO plant would reduce TDS to below 750 mg/L, hardness to below 150 mg/L, and sulfate to below 150mg/L.

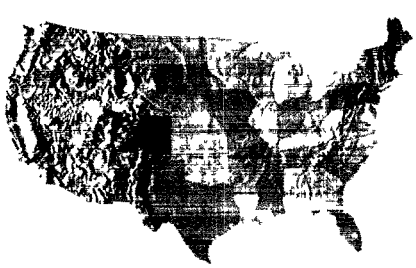
▲ *A 50-foot-by-80-foot building houses all of the treatment processes for the Las Animas RO treatment plant*

Boyle subsequently produced a final design for the new RO plant. Because of the high scaling potential of the feed water, the RO process was designed to operate at 50 percent recovery using a single stage. The treatment plant was designed with two 0.5-MGD trains, including a 10 percent blend of raw water. Pretreatment consists of scale inhibitor addition and cartridge filtration. Post-treatment includes CO_2 stripping and chemical addition for pH adjustment, corrosion control, disinfection, and fluoridation. All of the processes are housed in a 50-foot-by-80-foot building.

Money for the new plant came from a combination of grants and low-interest loans from three agencies:

- U.S. Department of Agriculture – $1.149 million in loans and $1.1 million in grants
- U.S. Economic Development Administration – a grant for $847,000
- Colorado Division of Local Governments – a grant for $300,000

Since startup, the plant has been a big success within the city of Las Animas and was the topic of a cover story in the *AWWA Journal*. The city is covering the new plant's operation and maintenance costs by slightly raising its water rates, but in turn, residents save on the costs of bottled water, water softeners, plumbing fixtures, and detergent. On top of that, the convenience factor is a major benefit.



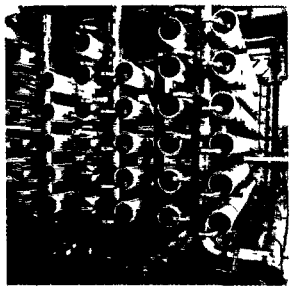
Las Animas, Colorado

Getting the Most out of Reverse Osmosis on Marco Island

Florida Water Services Corporation is the largest private-investor-owned utility in Florida. Boyle is helping the utility meet the short-and long-term water needs for a popular island.

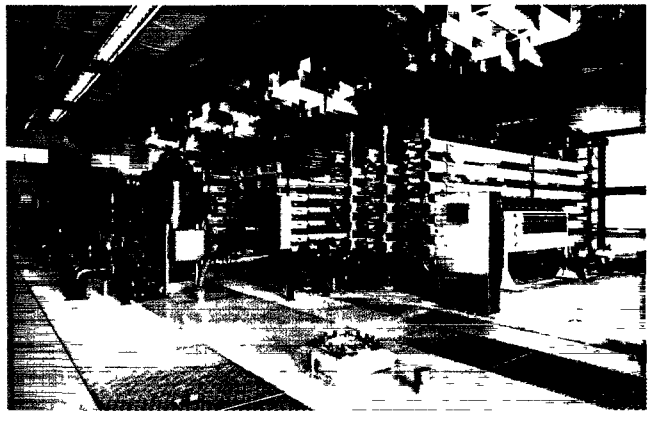
Located on Florida's southwest coast, Marco Island is home to about 23,000 permanent residents. In addition to the locals, the tropical climate and lush beauty of the area attract thousands of seasonal visitors who come to enjoy the sun and surf. The large fluctuation in the number of visitors that play on the island presents a challenge for Florida Water Services Corporation (Florida Water) when it comes to providing water and wastewater services. Florida Water is more than up to the challenge, however, especially with the help of Boyle Engineering Corporation.

As general consultant to Florida Water, Boyle has put its water treatment expertise to good use. The firm first reviewed Florida Water's water treatment facilities located on the island and prepared an action plan to improve water service to customers. The plan identified both a future need for the rehabilitation and eventual replacement of a lime softening water treatment plant and an immediate need for providing additional capacity at a 4-MGD reverse osmosis (RO) water treatment plant. The RO facility treats very salty water (approximately 30 percent of that found in the ocean) that varies in quality throughout the year. At this time, the RO plant treats the highest-salinity groundwater supply known to be in use in the United States.

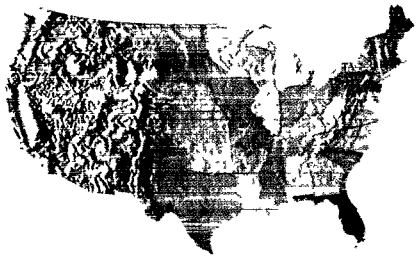


◀ *Reverse osmosis effectively treats high-salinity groundwater for Marco Island, Florida.*

To provide the additional capacity, Boyle engineers designed a 1-MGD expansion to the RO facility. Because of the need to provide treatment of a highly variable brackish water supply, Boyle proposed the use of an interstage turbine for energy recovery and enhanced water treatment in the design of the expansion. This is the first known use of an interstage turbine in a brackish water treatment application. The 1-MGD expansion was completed within six months of design, using fast-track design and a modified design/build delivery system. The owner negotiated with Boyle for the design and engineering services prior to negotiating with the contractor based on a qualifications-based selection process that Boyle and Florida Water implemented together. The construction contract was negotiated using 30-percent-complete design and specifications prepared by Boyle. During construction, the project was handled similarly to a design/build procurement process, with Boyle acting as the owner's agent.



▶ *Boyle helped Florida Water expand and upgrade a reverse osmosis water treatment plant that serves thousands of permanent residents and seasonal visitors of Marco Island.*



Marco Island, Florida

As a result of the success of the expansion, and because the innovative use of an interstage turbine indicated significant energy savings could be achieved by its use, Boyle was asked to implement a retrofit program for the original 4-MGD RO process. The retrofit design of an interstage turbine into existing RO process units proved to be a major challenge, but it was overcome by implementing the negotiated design/build procurement process that proved so successful in the expansion. The end result is an upgraded, energy-saving facility that produces the highest-quality drinking water for its customers.

Thanks to a partnering agreement amongst all involved parties, the improvements at the Marco Island RO facility were completed on schedule, within budget, and with minimal changes or problems during construction. As a result of Florida Water's commitment to provide quality services to its customers, and in part because of the design work by Boyle and the negotiated construction work by Harn R/O Systems, the plant won the coveted **"1998 Most Improved Water Treatment Plant Award"** from the Florida Section of the American Water Works Association.

Pilot Testing for Elegant Water Needs in Beverly Hills

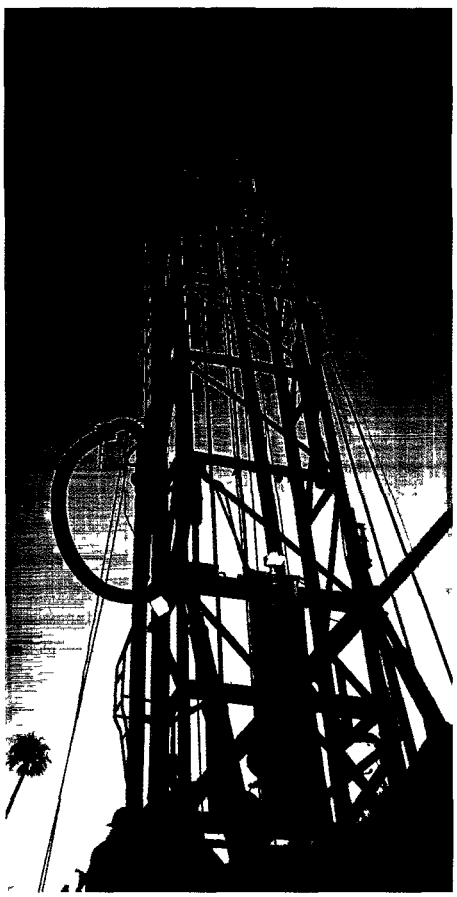
Hoping to develop its own water supply and reduce its dependency on imported water, the city of Beverly Hills retained Boyle Engineering to conduct an eight-month pilot test.

The city of Beverly Hills, California, is known worldwide as an affluent, upscale community. However, beyond the exclusive shops on Rodeo Drive, the ubiquitous limousines, and the plethora of mansions, there is a city that must provide the same public services as Anytown, U.S.A. Beverly Hills currently purchases its potable water from the Metropolitan Water District of Southern California (MWDSC), but would like to develop its own supply as a supplemental source.

Prior to 1976, the city had its own groundwater source to augment the water it received from MWDSC. Unfortunately, water-quality problems led to the discontinuation of groundwater use. To determine the feasibility of reestablishing groundwater production, the city retained Boyle Engineering Corporation to conduct a pilot test. Phase I of the project involved a hydrologic investigation to identify a potential groundwater production zone. The second phase consisted of two components: the design and construction of a test/production well, and an eight-month pilot test.

Mike Niedringhaus

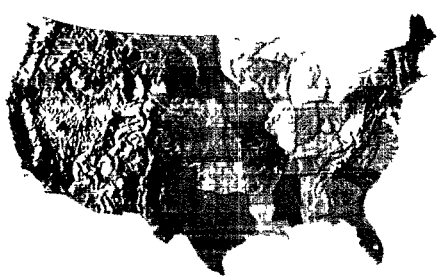
▲ *A pilot test indicated that reverse osmosis is an ideal treatment method if the city of Beverly Hills decides to develop a local groundwater supply.*



Mike Niedringhaus

▲ *The city of Beverly Hills, California, hopes to develop its own groundwater supply.*

The raw water from the test/production well had elevated levels of total dissolved solids (TDS), hardness, and iron and manganese. It also had a strong odor caused by hydrogen sulfide. The pilot study concentrated on reverse osmosis and nanofiltration to reduce TDS and hardness, and on air stripping, ozonation, and hydrogen peroxide oxidation to remove hydrogen sulfide. Boyle team members selected these processes because of their effectiveness in similar situations throughout the country. The results of the pilot study indicated that reverse osmosis is better for treating TDS and hardness, while air stripping is the best treatment method for hydrogen sulfide.



Beverly Hills, California

Based on its test findings, the project team made several important recommendations to the city:

- Construct additional wells and test for water quality.
- Use reverse osmosis as the preferred membrane treatment process to reduce TDS and hardness.
- Pretreatment for a reverse osmosis system should consist of desanding and pH adjustment.
- Use one air stripper to remove hydrogen sulfide from reverse osmosis permeate water, and one to remove it from the concentrate stream prior to storm drain discharge.

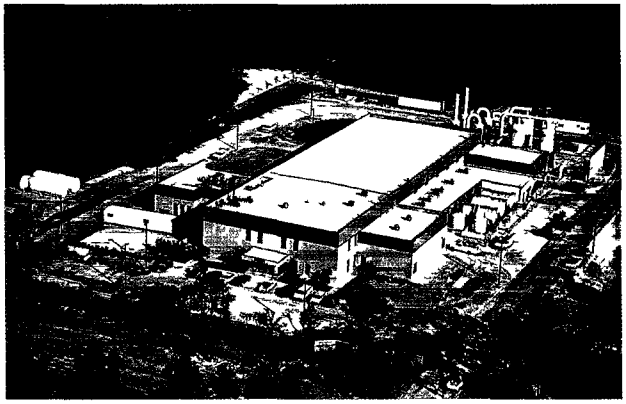
Data obtained during the pilot test helped the project team refine costs for a full-scale treatment project. The updated capital cost, including a new wellfield, treatment facilities, and system interconnections, is $12.1 million, with annual operations and maintenance costs estimated to be approximately $1 million. These costs compare favorably to the cost of imported water, so the city's reputation for having good taste may soon extend to its own water supply!

A Quick Look at Water Treatment

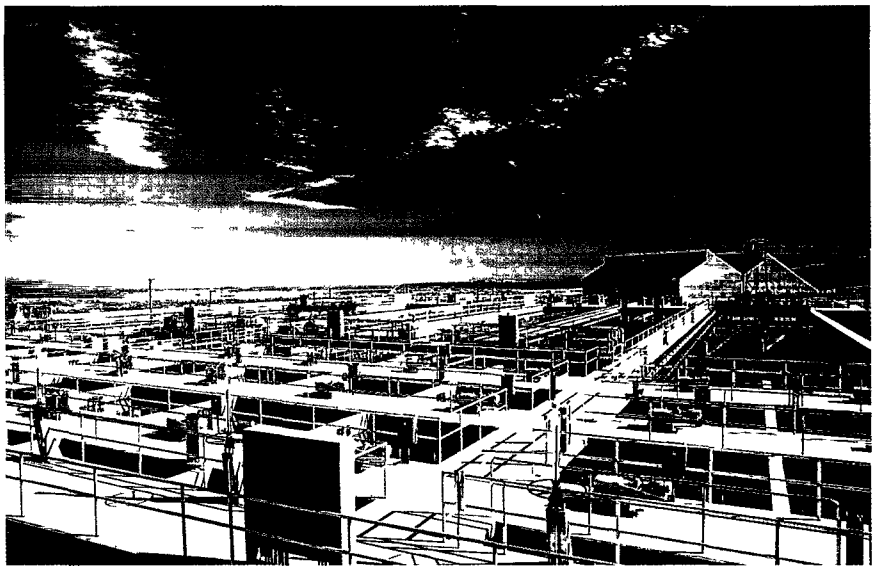
Siting and Analyses for Four Potential Water Treatment Plants

Under an existing contract, the New Mexico/Texas Water Commission authorized Boyle to perform siting and analyses studies for four potential water treatment plants: a 2-MGD plant in the city of Hatch, New Mexico; a 25-MGD plant in the city of Las Cruces, New Mexico; an 80-MGD plant in the northwest area of El Paso, Texas; and a 105-MGD regional plant for southern New Mexico and northwest El Paso. Boyle team members, with Parsons Engineering Science, Inc., as a subconsultant, identified conceptual sites for the plants and evaluated various treatment processes for each proposed facility. In reviewing possible plant sites, Boyle took into account infrastructure improvements necessary to deliver raw water to, and treated water from, each location. Specific siting criteria for each site included parcel size, ownership and zoning, residential buffer, floodplain location, primary/secondary vehicular and rail access, power/natural gas availability, and hydraulic feasibility.

The treatment processes considered by the project team included a host of conventional and advanced methods, including flocculation, sedimentation, membrane filtration, and granular activated carbon. Capital and operations and maintenance costs for each method were combined with the necessary expenses for infrastructure improvements, providing comprehensive cost breakdowns for all possible scenarios. Boyle concluded the project by developing a list of preferred sites and treatment processes.



◀ *North Collier County Regional Membrane Softening Treatment Plant in southern Florida. As evidence of Boyle's flexible design, the 12-MGD plant has the capability to expand to 20 MGD and to convert to low-pressure reverse osmosis. The client is the Collier County Utilities Division.*



▲ *Quartz Hill Water Treatment Plant in Southern California. One of several conventional treatment plants designed by Boyle for longtime client Antelope Valley-East Kern Water Agency. The treatment plants are part of a major water supply project known as the Domestic-Agricultural Water Network.*

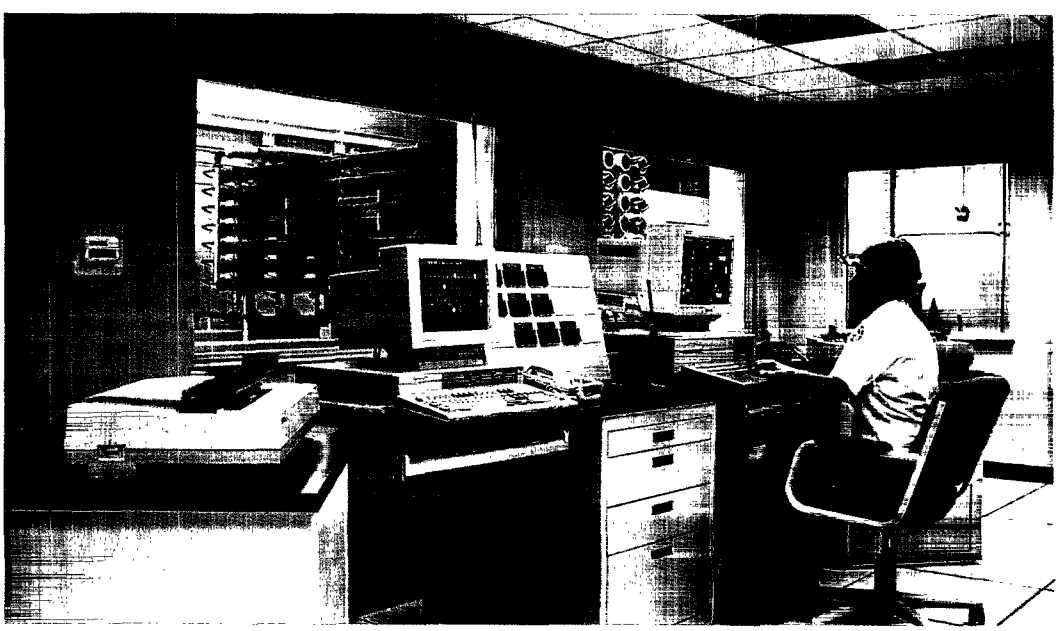
A Quick Look at Water Treatment (cont'd)

Mike Niedringhaus

▲ *Westlake DE Filtration Plant in Southern California. Working for the Las Virgenes Municipal Water District, Boyle engineers designed a 20-MGD diatomaceous-earth (DE) filtration plant that filters matter such as algae from treated water coming from an open reservoir.*

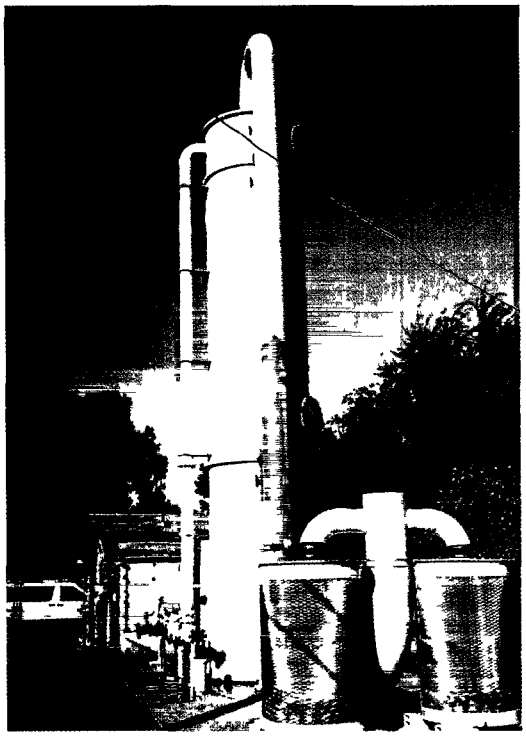
Solving a Water Problem in Texas

The city of Seymour, Texas, has experienced high nitrate and hardness levels in its water supply. After several studies to determine whether ion exchange or reverse osmosis (RO) was the optimum method of improving the water, the city decided to build an RO plant and retained Jacob & Martin (a local engineering firm) and Boyle to handle design. The project team produced a design for a 3-MGD plant, which should undergo construction starting in the late summer or early fall.



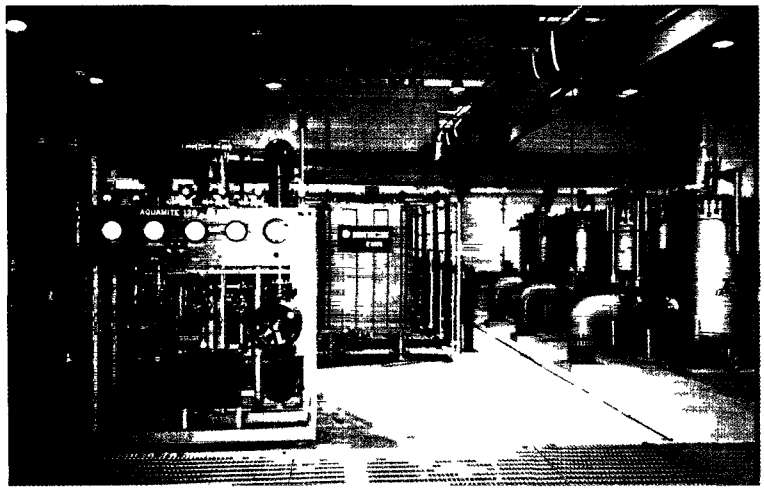
Mike Niedringhaus

▶ *Vero Beach Reverse Osmosis Water Treatment Plant, Vero Beach, Florida. Boyle designed this plant to operate in conjunction with a lime softening plant for the city of Vero Beach.*



◀ *Air-stripping wellhead treatment plant for the city of Fresno, California. Boyle has designed more than 20 wellhead treatment facilities for the city of Fresno (see full-page writeup in this issue), including two air-stripping units.*

▼ *T. Mabry Carlton, Jr. Water Treatment Plant in Sarasota County, Florida. This Boyle-designed facility went online as the largest electrodialysis reversal water treatment plant in the world. The 12-MGD plant has enabled Sarasota County to develop a new water source.*



Water Supply Feasibility Study In Florida

The city of Oldsmar, Florida, currently purchases its drinking water from regional wholesale suppliers, but is considering options to produce its own water supply. To determine the feasibility of such an undertaking, the city selected Boyle to conduct a water supply study. Working with a subconsultant named ViroGroup, Boyle reviewed regional hydrogeological and water quality data, performed site-specific well testing to determine hydraulic characteristics and vertical water quality profiles, and developed a conceptual facilities plan for a new wellfield and water treatment plant. Preliminary study results indicated that the area has sufficient brackish groundwater to develop a sustainable supply, with proper treatment by a low-pressure reverse osmosis facility. The project team's cost estimates for the city to construct and operate new well and treatment facilities compare favorably to the price of purchasing water from wholesalers. Furthermore, the concept is consistent with the New Water Source Initiative promoted by the Southwest Florida Water Management District.

New Treatment Plant Is Timely for a Growing Area

Attracted by scenic surroundings and a desirable quality of life, more and more people are calling the city of Redding, California, home. The Buckeye Water Treatment Plant will help the city keep up with water demand.

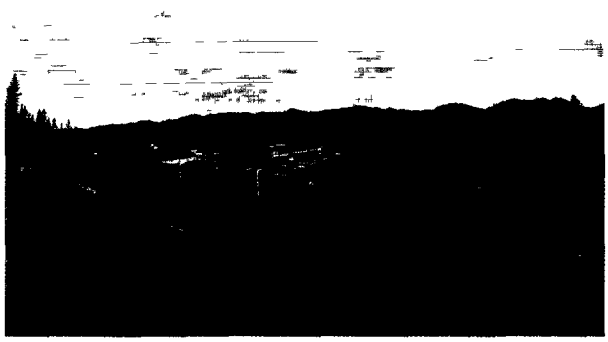
The city of Redding covers some 60 square miles in the picturesque upper region of northern California. Located 150 miles north of Sacramento and 100 miles east of the Pacific Ocean, Redding is home to more than 79,000 people, and that number continues to grow.

The growth in and around the city led to concerns about water supply and demand, particularly for an area known as the "Buckeye Zone." Ultimately, the city faced a decision to expand an existing water treatment plant or construct a new one. After opting for a new plant, the city retained Boyle Engineering Corporation to design a conventional 7-MGD multimedia facility known as the Buckeye Water Treatment Plant. To begin the project, Boyle prepared a preliminary design report for the new plant and for an affiliated treated-water transmission main. The report identified a plant site that was on 25 acres of land owned by the United States Bureau of Reclamation (USBR). After the completion of an Environmental Impact Report, Boyle completed final design of the treatment plant, which now sits on the USBR property as part of a 50-year land-lease agreement between the city and the bureau.

Though the Buckeye Water Treatment Plant is a conventional facility, there are many innovative aspects to the project. For instance, the plant can be expanded easily from 7 MGD to 14 MGD by using common basin walls and plant piping. Expansion to 28 MGD is possible by replicating the 14 MGD configuration. On the water-delivery side, no pumping is needed for the treated-water transmission main, which ties into the city's distribution system. Boyle engineers designed the four-and-one-half-mile, 30-inch-diameter transmission main to function as a gravity pipeline.

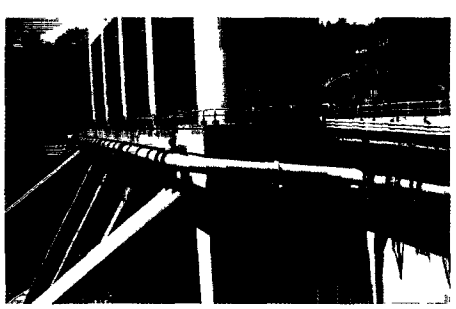
A portion of the treated-water transmission main is attached to Keswick Dam, a concrete structure located on the Sacramento River. Designing the Keswick Dam crossing involved computer technology and comprehensive field surveys. The final configuration also reflected the project team's consideration of dam operations, visual impacts, and pipeline construction and maintenance.

The treatment plant consists of two flocculation basins; two sedimentation basins; four gravity filtration units; a washwater-recovery basin; three sludge lagoons; an operations building that houses the main office, lab facilities, chemical storage and feed systems, and a control room; a filter-control building that contains filter-control consoles and other electrical controls; and a utility building where an emergency engine generator is located.

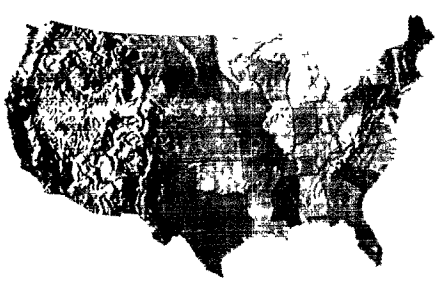


Mike Niedinghaus

▶ *The Buckeye Water Treatment Plant sits on 25 acres of land leased from the United States Bureau of Reclamation. Construction of the plant finished ahead of schedule, and the cost for the entire project was under budget.*



▲ *A portion of the treated-water transmission main designed by Boyle runs across the face of Keswick Dam.*



Redding, California

A Boyle-designed supervisory control and data acquisition (SCADA) system allows the plant to operate unmanned, with routine checks by a city employee. Plant processes are controlled from another water treatment plant. If necessary, an operator can monitor and control the plant from home via a portable notebook computer. Key components of the SCADA system include PC and notebook computers, programmable logic controllers, and telemetry equipment.

The combined cost of the treatment plant, pipeline, and SCADA system was $10.3 million, which was approximately $330,000 under budget. Cost savings aside, the Buckeye Water Treatment Plant is vital to the growth of Redding. It not only serves an immediate need, but provides the city a great deal of luxury in meeting long-term water demand.

A multifaceted water supply facility in central Florida incorporates state-of-the-art water treatment with adaptability and diverse public service potential.

Orange County, Florida, Is Site of New Regional Water Supply Facility

▶ *Flexibility is one of the main features of the Eastern Regional Water Supply Facility For instance, drilling new onsite wells is just one way to increase plant capacity.*

Orange County, Florida, is well known as a popular tourist destination. Picture-perfect sunny skies and fantastic theme parks are what come to the minds of most people when they think of the region. What comes immediately to mind for the Orange County Utilities Division is a new forced-draft aeration water treatment plant designed by Boyle Engineering Corporation. The 20-MGD Orange County Eastern Regional Water Supply Facility not only has the capability to be expanded to 80 MGD, but it also can act as a field-operations center during hurricanes and other natural disasters.

Boyle provided total engineering services from conceptual design through startup of the Eastern Regional Water Supply Facility. With each task, engineers were challenged to provide innovative techniques in water treatment. For instance, in the process to remove hydrogen sulfide from groundwater, pH pretreatment required the use of either carbon dioxide or sulfuric acid. Although both chemicals provided equivalent hydrogen sulfide removal, pilot testing by Boyle showed that the use of carbon dioxide was more cost-effective and resulted in no loss of natural alkalinity and in a finished water that was stabilized.

▲ *Occupying some 466 acres, the Eastern Regional Water Supply Facility is not your average treatment plant. Among other things, it is the central control center for all of the county's other plants*

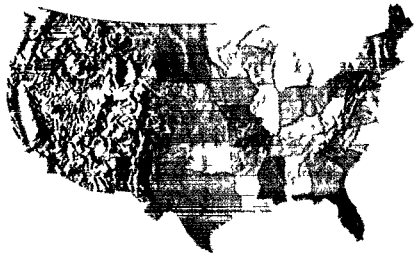
The production of stable water was a key project objective relative to corrosion control. In addition, handling of carbon dioxide poses fewer dangers than does the handling of sulfuric acid. Ultimately, carbon dioxide was chosen over sulfuric acid for the pH pretreatment.

Providing a balanced, flexible design was paramount to the Boyle team, and as a result, the facility can be easily upgraded to meet new and pending water quality regulations. For example, forced-draft aeration can become a post-treatment method if other advanced treatment becomes necessary to meet future regulations. To provide this flexibility, a hydraulic system was designed for the easy addition of advanced treatment systems such as ozone or membrane treatment.

Along with providing for future upgrades in terms of treatment processes, Boyle put a lot of forethought into facility expansion. Adding capacity will involve increasing the number of onsite 5-MGD wells from four to seven and eventually accommodating offsite wells and connecting to a wellfield at the county's Econ Water Treatment Plant.

Located on a 466-acre site, the Eastern Regional Water Supply Facility is the central control center for all of the county's water treatment plants. Operators at the Eastern Regional Water Supply Facility can access and control 19 other plants in the county through radio telemetry. Also, the facility is outfitted with a heavy bridge crane, machine shop, and welding equipment for repairs. And it doesn't stop there. The facility is visitor friendly, and the Orange County Utilities Division plans to conduct school field trips and other water-related public education programs at the plant.

The plant's 38,000-square-foot operations building can withstand 120-mph winds. It is designed to function as a live-in command center for county staff, primarily during natural disasters like hurricanes. It boasts food preparation areas to serve large groups, dormitory-style sleeping quarters, numerous storage facilities, and emergency power generators with ample fuel storage.



Orlando, Florida

Central California Cities Rely on Wellhead Treatment

The cities of Fresno, Clovis, Dinuba, Reedley, and Madera have taken a heady approach to groundwater contamination. One of their smart moves was to call on Boyle Engineering.

Wellhead treatment facilities are sort of the antitheses of multimillion-gallon-per-day water treatment plants. Instead of occupying large sites and having most of their components housed in a building, wellhead treatment facilities require relatively little space and are essentially outdoor units. They are especially effective for reducing concentration levels of groundwater contaminants like dibromochloropropane (DBCP) and ethyl dibromide (EDB).

DBCP and EDB were once popular pesticides until their link to cancer and sterility led to an EPA ban beginning in the late 1970s. In and around the city of Fresno, California, DBCP and EDB have migrated into groundwater, which serves as the main potable supply source for the area. To reduce the levels of DBCP, EDB and other organic-chemical contaminants to drinking water standards, Fresno and several nearby cities have retained Boyle Engineering Corporation to design wellhead treatment facilities. Already, Boyle team members have designed more than 20 wellhead treatment facilities for the city of Fresno; two each for the cities of Clovis, Dinuba, and Reedley; and one for the city of Madera.

Most of the nearly 30 wellhead treatment facilities involve the use of Granular Activated Carbon (GAC) pressure vessels. Groundwater passes through the GAC-filled vessels, where contaminants are adsorbed and removed by the carbon. The number of GAC vessels necessary for a given site varies, and Boyle has designed GAC systems that have only one or as many as six vessels.

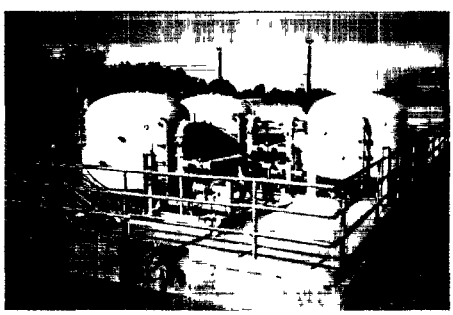
◀ *Boyle recently designed an iron and manganese wellhead treatment facility for the city of Fresno.*

Just as the number of vessels varies, so does the length of time for design and construction. Yet another variable is the cost to complete a GAC treatment facility, which ranges from approximately $250,000 to $1 million. On one of the larger projects for the city of Fresno, Boyle prepared plans, specifications, and a cost estimate for the installation of a four-GAC-vessel centralized treatment facility serving multiple wells. The capacity of the facility is 3,000 gpm.

Besides GAC filtration systems, Boyle's wellhead treatment projects in central California consist of the design of two air stripping towers and two iron and manganese units. One of the air stripping towers is near an air terminal in Fresno. The facility treats groundwater contaminated by an organic solvent known as trichloroethylene (TCE). Inside the 50-foot-tall, 108-inch-diameter tower are plastic media. Untreated water enters the tower from the top and cascades down through the media while a blower sends air upward to volatilize and remove the TCE.

Central, California

The iron and manganese process uses sodium hypochlorite and sodium bisulfate to oxidize the iron and manganese in untreated water and remove any traces of hydrogen sulfide. Then, a pressure-filter vessel filled with proprietary media removes the iron and manganese oxides before the potable water enters the distribution system. A backwash system periodically flushes the accumulated oxides from the filter vessel to a backwash water recovery tank, and in the case of Fresno, the settled precipitates eventually drain into the city's sanitary sewer system.



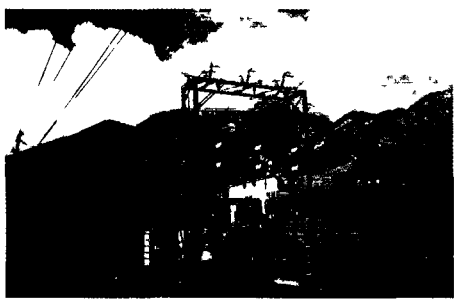
▲ *The GAC wellhead treatment facility for Well #137 is neither the largest nor the smallest designed by Boyle for the city of Fresno. With three vessels, the facility treats 1,800 gpm.*

"Whether it is GAC systems, air strippers, or iron and manganese units, wellhead treatment likely will continue to rise in popularity," according to a Boyle engineer. He is quick to add that, as more communities turn to wellhead treatment, Boyle will remain a leader in the field.

Electrical System Improvements Re-Energize Water Treatment Plant

The upgrade at the Little Cottonwood Water Treatment Plant was not the typical expansion of treatment facilities, but rather the replacement of electrical system components. Still, it was all in a day's work for Boyle Engineering.

The Little Cottonwood Water Treatment Plant is a 113-MGD conventional facility in Salt Lake City, Utah. Built in the late 1950s, the plant serves a growing customer base that already exceeds several hundred thousand people. To enable the plant to continue operating at maximum efficiency, electrical system improvements became necessary. That's because much of the electrical equipment had surpassed its life expectancy, and minor power-related problems occasionally surfaced. The owner of the plant, the Metropolitan Water District of Salt Lake City (MWDSLC), sought assistance from Boyle Engineering Corporation, which has a talented team of electrical engineers.



▲ *Visible behind the steel structure is a newly constructed 50-foot-by-35-foot building designed by Boyle to house a standby generator and switchgear.*

Boyle electrical engineers began the project with a site visit. They surveyed electrical equipment at the plant, collected electrical measurements, conducted a test of the backup engine generator, and investigated previously identified electrical system anomalies, such as interference on the closed-circuit television system. Besides visiting the site, the project team reviewed plant drawings, records, past studies, and related documents. They then prepared a comprehensive report that described the existing condition of the plant's electrical system components. The report also contained recommendations for improvements, which included replacing the electrical-distribution equipment and wiring, the backup engine generator, the transformer load centers, the lighting transformers, and the panelboards.

MWDSLC reviewed Boyle's suggested upgrades and authorized the firm to proceed with design. During a six-month period, project team members produced plans and specifications for a 46- to 12-kilovolt (kV) substation transformer, 12-kV switchgear, 12-kV feeder cables, low-voltage power wiring, three load centers, motor control centers, lighting transformers and panelboards, and a standby generator.

A couple of Boyle's structural and mechanical engineers designed a new 50-foot-by-35-foot building to house the standby generator and switchgear. With design input from a Boyle architect, the building's exterior complemented the other plant buildings.

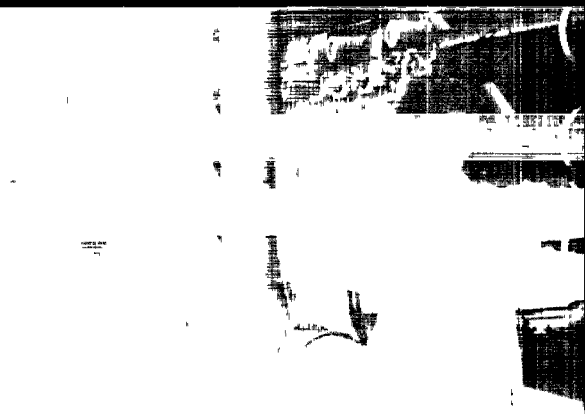
Having planned and designed the $4-million electrical upgrade of the plant, Boyle was the logical choice to provide construction observation. A Boyle engineer remained onsite throughout the 13-month construction period. He worked closely with MWDSLC and the contractor to help construction proceed according to plans and specifications and to resolve problematic issues quickly. A partnering agreement amongst Boyle, MWDSLC, and the contractor created a harmonious relationship that allowed the project to finish two months ahead of schedule.

▶ *The Little Cottonwood Water Treatment Plant benefited from a major electrical upgrade designed by Boyle.*

The plant's electrical system is now completely up to date and capable of functioning optimally for a long time to come. To help plant employees monitor the newly installed equipment, as well as electrical components that were not part of the upgrade, Boyle developed a computer-based power-management system. In addition, Boyle prepared a complete set of electrical drawings that MWDSLC can use for troubleshooting at the plant.

Salt Lake City, Utah

Trihalomethanes and Your Health



Water is the most basic necessity of life, and water utilities rely on disinfection to help ensure that their water is safe to drink. Recognition of the need to disinfect water supplies dates back to the end of the 19th century, when deaths from typhoid and cholera were common in large metropolitan areas. The practice of using chlorine as a drinking water disinfectant to prevent acute water-borne disease was initiated in 1908 and has since proven to be one of the most important public health measures that water utilities in the United States have undertaken this century. By 1914, the continuous addition of chlorine to water systems resulted in a significant decrease in the number of water-borne-disease cases reported, and ever since the practice became routine, the average life expectancy of a normal person has almost doubled.

◀ *Safe drinking water is vitally important to every person and every community.*

Oddly, however, the same chemical that has historically been used to protect us from becoming ill has now been shown to be responsible for creating suspected carcinogenic compounds called trihalomethanes. Trihalomethanes, a group of four individual chemical contaminants that have been shown to cause cancer in laboratory animals, are a byproduct of the chemical reaction between chlorine and decaying plant material in the environment. Decaying plant matter consists primarily of organic carbon and is found in lakes, reservoirs, rivers, and some groundwater supplies. Besides trihalomethanes, other disinfection byproducts are also suspected carcinogens, such as bromate (a byproduct of ozone treatment) and haloacetic acids (additional byproducts of chlorine treatment). The levels of these suspected carcinogens in tap water depend on the source of water, the disinfection method, and other factors.

Several epidemiology studies have evaluated the link between disinfection and adverse outcomes such as cancer, cardiovascular disease, and pregnancy problems. Some studies have reported small increases in bladder, colon, and rectal cancers. New research conducted by the California Department of Health Services has found that pregnant women who, in their first trimester, drink more than five glasses daily of cold tap water containing high levels of common contaminants have higher rates of miscarriage than women who do not drink as much. The women who were exposed to high levels of a particular trihalomethane, bromodichloromethane, had three times the average miscarriage rate. While this more recent study is not conclusive, the California Department of Health Services advises that pregnant women should consult with their doctor and that those concerned can boil water for two minutes to remove most of the trihalomethanes.

As with other reported adverse outcomes from these studies, there is considerable scientific debate on the significance of these findings. Although the results of these studies are being evaluated in further detail, the USEPA is thinking of lowering the accepted standard for trihalomethanes in drinking water from 100 to 80 parts per billion. In the midst of all of this, people should realize that, when it comes to your health, the benefits of chlorine disinfection of water far outweigh the risks associated with trihalomethanes. For instance, chlorine is responsible for wiping out risks associated with microbes that cause cholera, dysentery, and typhus.

Boyle engineers and scientists are involved in projects nationwide designed to improve water quality in drinking water systems. Boyle has helped pioneer the use of membrane and ion-exchange water treatment processes, two methods that have been successful in removing the natural organic material from water prior to disinfection, thereby eliminating a major contributing source to disinfection byproducts. For more information on this subject, please contact Dr. Steve Duranceau in Boyle's Orlando, Florida, office at (407) 425-1100, extension 304.

In Focus...

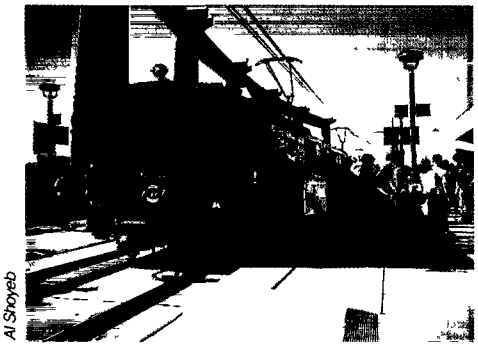
Trolley Extension Wins Awards

Under contract to the San Diego Metropolitan Transit Development Board (MTDB), Boyle designed a 6.1-mile, $231-million trolley extension known as Mission Valley West.

Al Shoyeb

▲ *Mission Valley West*

Operational since last November, Mission Valley West runs parallel to, and provides relief for, San Diego's busiest freeway. It also includes a stop at Qualcomm Stadium, which not only hosts more than 200 major events each year, but was also the site of the 1998 Super Bowl. Mission Valley West was the first MTDB trolley project to have elevated trolley stations, a two-level multimodal transit station, a stop at a major sports stadium, and approximately three miles of track on structures. In addition, Mission Valley West is the first San Diego Trolley line to lie outside MTDB's existing right-of-way and to not use public streets. Almost unbelievably, the project was completed ahead of schedule and under budget. Two professional societies recently bestowed awards on the project: **"1997 Outstanding Civil Engineering Project Award – Major Transit,"** American Society of Civil Engineers, San Diego Section; **"Architectural Concrete Project of the Year for the Stadium Station"** and **"Concrete Bridge Project of the Year for the Mission Valley West Trolley Bridges,"** San Diego International Chapter of the American Concrete Institute.



Al Shoyeb

▲ *Mission Valley West*

Boyle Engineers Win Awards

Two Boyle engineers recently received merit awards from the Orange County Engineering Council (OCEC), while another staff member was a recipient of a commendation from the Institute for the Advancement of Engineering (IAE). Dan Whyte, PE, and Roxanne Perez, EIT, were the OCEC winners. Whyte, managing engineer of Boyle's Orange County office, received an "Outstanding Engineer Merit Award." Perez, a transportation specialist in the Orange County office, earned a "Young Engineer Award." The IAE award-winner was Bruce Mattern, PE, TE, who is an assistant managing engineer in the Orange County office. He was one of several honorees of the "Leadership in Engineering Award."

▲ *Dan Whyte*

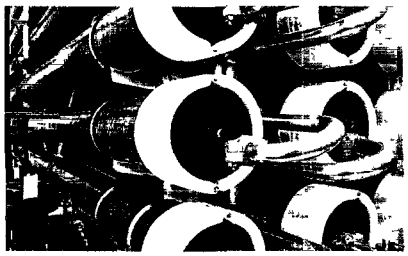
▲ *Bruce Mattern*

▲ *Roxanne Perez*

Boyle Opens New Office in Fort Worth, Texas

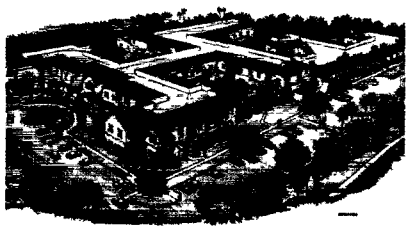
By opening a Fort Worth office about an hour away from its Dallas office, Boyle now has two talented teams to serve clients in east Texas. Both offices provide multidisciplinary engineering services, including water resources and transportation. The Fort Worth office's address is 309 West 7th Street, Suite 720, Fort Worth, TX 76102. You can also reach the staff by phone at (817) 820-0010 or by fax at (817) 820-0034. The Dallas office is located at 6606 LBJ Freeway, Suite 100, Dallas, TX 75240. The phone number in Dallas is (972) 233-6606, and the fax number is (972) 239-8832.

Previews...



Orange County, California – The Irvine Ranch Water District recently selected Boyle/Orange County to provide vital support for an 8-MGD nanofiltration water treatment plant project. Boyle's initial responsibilities include preliminary design and the preparation of procurement documents for the selection of a design/build team. When constructed, the plant will serve as the first full-scale treatment facility in Orange County to treat water from a deep groundwater basin that has remained untapped because of excessive concentrations of color and organics.

Fort Worth, Texas – Boyle/Fort Worth is one of several consultants that will provide design services for the city of Fort Worth's $120-million capital improvements bond program. The initial assignment for Boyle includes the preparation of plans and specifications for the reconstruction of portions of two roadways: Pine Street and Riverside Drive. The design will cover associated water mains and sanitary sewer improvements.



Palm Springs, California – Marriott International selected Boyle/San Diego to provide engineering services for a first-of-its-kind senior-citizen living center in Palm Springs. Boyle's team will help obtain project approval from the city, prepare due-diligence reports, oversee surveying, develop a grading plan, produce infrastructure designs, and provide construction services. Marriott has named the assisted-living complex the Hearthside.

Sarasota County, Florida – Sarasota County selected Boyle/Sarasota to conduct a stormwater study of St. Armand's Circle, an upscale shopping and dining area that is popular with tourists on Long Boat Key. Located adjacent to the Gulf of Mexico, Long Boat Key is an island with tidally influenced drainage and frequent flooding. Project team members will explore innovative drainage solutions such as check valves on storm sewer pipes operating in conjunction with a major pump station.

BOYLE
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